PRELIMINARY GEOTECHNICAL SERVICES REPORT PROPOSED TIDEWATER CROSSING PROJECT STOCKTON, CALIFORNIA

JUNE 21, 2006

File No. 64183.G01
June 21, 2006

Mr. Ron Weldum
H.D. Arnaiz Development
3400 E. Eight Mile Road, Suite A
Stockton, California 95212

Subject: Preliminary Geotechnical Services Report
Proposed Tidewater Crossing Project
Stockton, California

Dear Mr. Weldum:

Kleinfelder is pleased to present the results of our preliminary geotechnical study performed for the proposed Tidewater Crossing project to be located east and west of Airport way and north and south of French Camp Slough in Stockton, California. The accompanying report includes background information regarding the anticipated construction, the purpose of our services, and scope of services provided. In addition, discussions regarding our investigative procedures and the site conditions encountered during our field exploration are presented. Finally, geotechnical conclusions and recommendations are provided for project design and construction. The appendix of the report includes logs of borings and a summary of laboratory tests. We have also included an information sheet published by ASFE. Our firm is a member of ASFE, and we feel this sheet will help you better understand geotechnical engineering reports.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact our office.

Sincerely,

KLEINFELDER, INC.

Saeed Parsa
Staff Engineer

Reviewed by:

Ron Heinzen, G.E.
Senior Principal/Client Service Manager

REGISTERED PROFESSIONAL ENGINEER
RONALD TERRY HEINZEN
No. 388
Exp. 3-31-07
GEOTECHNICAL
STATE OF CALIFORNIA

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KLEINFELDER
An employee owned company

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PRELIMINARY GEOTECHNICAL SERVICES REPORT PROPOSED TIDEWATER CROSSING PROJECT STOCKTON, CALIFORNIA

1.0 INTRODUCTION

In this report we present the results of our preliminary geotechnical study performed for the proposed Tidewater Crossing project to be located in Stockton, California. The site location relative to existing streets is shown on Plate 1.

We understand that design of the proposed project is in the conceptual stages and preliminary details are not available as of this writing. On a preliminary basis, we understand the project will consist of light industrial, commercial, and high-density and single-family residential developments. The residential areas will be located south of French Camp Slough while the industrial and commercial areas will be located north of French Camp Slough. An open area will be preserved along both sides of French Camp Slough.

Since the types of building and locations of the buildings in the industrial/commercial areas have not been determined, we have assumed that construction will consist of wood- or steel-framed structures with metal exteriors, concrete tilt up, or masonry CMU structures. These buildings may be tall, one-story with mezzanine structures with concrete slab-on-grade floors. Maximum foundation loads for similar type structures with which we are familiar have ranged from 2 to 3 kips per linear foot dead plus live loads for perimeter or interior wall loads. Maximum isolated column loads have been in the range of 60 to 100 kips for dead plus live load. Foundation recommendations for these types of structures will only be preliminary. As final design plans are completed for this area, additional geotechnical services studies should be performed for specific building locations and structures.

We have assumed that the single-family residences will consist of one- and two-story, wood-framed structures with concrete slab-on-grade floors. Typical maximum foundation loads for perimeter walls are expected to be in the range of 1 to 2 kips per linear foot for dead plus live loads. Maximum isolated column loads are expected to be in the range of 30 to 40 kips for dead plus live loads.

The types and locations of the high-density residential units have not yet been determined. Additional geotechnical studies should be performed for these structures once their locations and sizes have been determined.

We have assumed that numerous streets will be constructed in both the residential and industrial/commercial areas of the project. Other construction will involve exterior concrete flatwork, such as sidewalks, curbs, gutters, etc. Several storm water runoff basins will also be constructed within the open space areas next to French Camp Slough. These basins may extend up to 30 feet below the existing ground surface.

Since grading plans are not currently available, proposed cuts and fills are unknown at this time. However, as site topography is relatively level, cuts and fills during earthwork are anticipated to be minimal (4 feet or less) to provide level foundation pads with positive site drainage. Excavations for underground utilities are not anticipated to exceed 20 feet below final site grade.

A plot plan showing the proposed project layout is presented on Plate 1. In the event these structural or grading details are inconsistent with the final design criteria, our firm should be contacted prior to final design in order that we may update our recommendations as needed.

2.0 PURPOSE AND SCOPE OF SERVICES

The purpose of our services was to explore and evaluate the subsurface conditions at various locations on the site in order to develop recommendations related to the geotechnical aspects of project design and construction.

The scope of our services was originally outlined in our proposal dated January 25, 2005 (Proposal No. STO5P036). Our scope was amended to include three piezometers in the area of proposed basin located north of the Union Pacific (UP) Railroad as shown on the site plan. Our final scope included the following:

- A visual site reconnaissance to investigate the surface conditions at the project site
- A field investigation that consisted of drilling borings and piezometers within the area of the proposed development to explore the subsurface conditions at the project site
- Laboratory testing of representative samples obtained during the field investigation to evaluate relevant physical and engineering parameters of the subsurface soils
- Evaluation of the data obtained and an engineering analysis to develop our geotechnical conclusions and recommendations
- Preparation of this report which includes:
  - ➢ A description of the proposed project
  - ➢ A description of the field and laboratory investigations
  - ➢ A description of the surface and subsurface conditions encountered during our field investigation
  - ➢ Conclusions and recommendations related to the geotechnical aspects of the project design and construction
  - ➢ A vicinity map/boring location plan, and
  - ➢ An appendix that includes logs of borings and a summary of laboratory tests.

3.0 FIELD AND LABORATORY INVESTIGATIONS

3.1 Field Investigation

The subsurface conditions at the site were first explored on February 15 and 16, 2006, by drilling seven borings to depths ranging from about 11½ to 47 feet below existing grade. Wet site conditions and farming activities prevented further test drilling in the northern portion of site until June 13 and 14, 2006, when eleven more borings were completed to depths of about 11½ to 27 feet. All borings were drilled using a Simco 2400 truck-mounted drill rig equipped with 4½ inch O.D. solid-stem auger. Borings B-1, B-2, and B-3 were converted to groundwater observation wells (piezometers) following the drilling operation. The approximate boring locations are presented on Plate 1.

During the drilling operations, penetration tests were performed in accordance with ASTM D-1586 at regular intervals using a Modified California Sampler to evaluate the relative density of coarse-grained (cohesionless) soil and to retain soil samples for laboratory testing. The penetration tests were performed by initially driving the sampler 6 inches into the bottom of the bore hole using a cathead system and a 140 pound trip-hammer falling 30 inches to penetrate loose soil cuttings and "seat" the sampler. Thereafter, the sampler was progressively driven an additional 12 inches, with the results recorded as the corresponding number of blows required to advance the sampler 12 inches, or any part thereof. A pocket penetrometer was used to evaluate the consistency of fine-grained (cohesive) soil samples retained. A representative with our firm maintained a log of the borings and visually classified the soils encountered according to the Unified Soil Classification System (see Plate A-1 of the appendix). Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance and brought to our Stockton laboratory for testing.

A key to the Logs of Borings is presented on Plate A-2 of the appendix. The Logs of Borings are presented on Plates A-3 through A-9 of the appendix. The borings were located in the field by visual sighting and/or pacing from existing site features; therefore, the locations shown on Plate 1 should be considered approximate. The penetration resistance (blows/ft.) shown on the logs of borings represents field penetration that has not been corrected for overburden pressure, sampler size, hammer type, borehole diameter, rod length, sampling method or any other correction factor.

3.2 Laboratory Investigation

Laboratory tests were performed in accordance with current ASTM standards on selected soil samples to evaluate their physical characteristics and engineering properties. The laboratory testing program was formulated with emphasis on the evaluation of natural moisture content, in-place density, grain-size distribution, percent soil passing the #200 sieve, and plasticity of the materials encountered. One resistance value (R-value) test was performed on a near-surface composite subgrade soil sample in order to evaluate preliminary pavement sections (see Plate A-13). Unconfined compressive strength results are presented on Plates A-11 and A-12. In addition, pH, minimum resistivity, sulfate concentration and chloride concentration tests were performed on the same composite soil sample to evaluate the general corrosivity of the soils to buried concrete and ferrous metals.

The results of laboratory tests are summarized on Plate A-10 in the appendix. This information, along with the field observations, was used to prepare the final test boring logs.

4.0 SITE CONDITIONS

4.1 Surface Conditions

At the time of our investigation, the site was a relatively-level, disced field in the northwest and northeast areas along South Airport Way and in the west and eastern portions of the property north of French Camp Road. The south portion of the project site consisted of an almond orchard that covered the area between French Camp Road on the south, Airport Road on the west, and Small Road on the east. The project site was bound on the north by neighboring farm lands and the UP Railroad, on the south by French Camp Road, on the west by a ditch and the UP Railroad, and on the east by existing farm lands. South Airport Way crossed the central portion of the site from north to south. A PG&E gas transmission line was observed near the south edge of the site, north of French Camp Road. An industrial facility was located near the western portion of the project site. Several ditches were observed throughout the property that included pump stations in some areas on the west side of South Airport Road. Several barns and storage-type structures were observed at different locations on the property.

4.2 Subsurface Conditions

Based on our findings, the subsurface soil generally encountered in our borings consisted of very-stiff to hard, dark-brown, moderately- to highly-plastic clay to depths ranging from about 3 to 5 feet below existing site grade. Exceptions included brown sandy and clayey silt or silty sand encountered to depths of about 1½ to 5 feet in borings B-4, B-5, B-15, and B-17. The less clayey soils in the vicinity of borings B-15 and B-17 are considered anomalies. However, the sandy silt soils in borings B-4 and B-5, both located in the extreme southern end of the project, are generally representative of the more sandy soils common in Manteca. This transition from clay to Veritas fine sandy loam is confirmed by the 1992 Soil Survey for San Joaquin County published by the Soil Conservation Service. These soils were underlain by interbedded layers of brown to light brown, fine- to coarse-grained, medium-dense to dense clayey and/or silty sand, hard sandy clay, and/or silt to the maximum depths explored. Loose, fine-grained, relatively "clean" and/or silty sand was encountered in boring B-5 to a depth of approximately 5 to 9 feet below grade.

Test borings B-1, B-2, and B-3 were checked for the presence of groundwater during and immediately following drilling operations. Groundwater was encountered at depths ranging from about 38¾ to 40½ feet below existing site grade. Groundwater was again measured on February 24, April 12 and 24, May 3, and June 14, and the results are presented on Plate A-14. Groundwater elevations and soil moisture conditions within the project area will vary depending on seasonal rainfall, irrigation practices, land use, and/or runoff conditions. In reviewing the data shown on Plate A-14, it is apparent that seepage from the adjacent small creek affected the readings on April 12. Excluding the potential for occasional seepage from rain-swollen creeks, it is our opinion that a reasonable design depth to groundwater would be 30 feet.

Detailed descriptions of the subsurface conditions encountered during our field investigation are presented on the Logs of Borings, Plates A-3 through A-9 of the appendix.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 General

Based on our findings, it is our professional opinion that the site should be suitable from a geotechnical standpoint for support of the proposed Tidewater Crossing project provided the recommendations contained herein are incorporated into the project design. Given the site conditions encountered, we believe conventional spread foundations and/or post-tensioned slab foundations should provide adequate support for the assumed residences. Conventional spread foundations should also provide adequate support for light industrial and commercial structures. The primary consideration identified from a geotechnical standpoint is the shrink-swell (expansion) characteristics of the near-surface clay and the potential for post-construction heave or uplift of concrete slabs, foundations and pavements. Specific conclusions and recommendations regarding the geotechnical aspects of design and construction are presented in the following sections. We have provided recommendations below assuming a mostly clay site as indicated by fourteen of our eighteen boring locations. As previously mentioned, however, it would be appropriate to consider alternative recommendations for the predominately sandy and silty soils found in the extreme southern portion of the site.

5.2 Concrete Floor Slabs

5.2.1 General

The near-surface soil underlying the site consists primarily of medium- to highly-plastic clay that, based on our data and experience, can exhibit significant expansion characteristics. This subsurface condition is common within the project area and poses a risk for post-construction heave and cracking of concrete slabs, as well as lightly loaded foundations and pavements. The terms *expansion* or *expansive soil* generally apply to any soil that has a potential for swelling or heaving with seasonal or man-made increases in moisture content. When reference is made to *swell* or *heave* potential it should be recognized that there also exists a potential for shrinking or settlement to occur due to decreases in soil moisture content or drying of the soil.

Several approaches can be taken to reduce the potential for post-construction heave. Typically the least risky approach would be to support the proposed residences on *post-tensioned slab foundations* that are designed to resist and/or span the expansive soils. Design criteria and subgrade preparation recommendations for post-tensioned slabs are presented in Section 5.5. If *conventional floor slabs* with interior and exterior bearing wall footings are proposed for residences and/or light industrial and commercial structures, three approaches are discussed in the following subsection to improve/modify the subgrade soil condition. Each approach has been successfully used in the project area and is considered reasonably cost-effective. Selection of the appropriate approach for the proposed project should be based on the risk tolerance of the project owner, among other factors. If there are questions regarding potential risks and life cycle costs with each approach, our firm should be consulted.

5.2.2 Subgrade Preparation

Based on the assumed project details, three alternatives (non-expansive fill, moisture conditioning, and lime treatment) are discussed below to improve/modify the subgrade conditions below conventional floor slabs.

Non-Expansive Fill – This approach tends to the least risk/higher cost alternative since the near-surface clay most susceptible to expansion is replaced with non-expansive soil. In addition, the non-expansive fill pad tends to provide some resistance to up-lift forces by increasing the dead-load imposed on the underlying clay and often produces a more uniform heave pattern with less differential movement if the underlying clay were to swell. This approach is very common for light industrial and commercial structures but is seldom used for residential structures due to cost.

This procedure consists of placing at least 12 inches of non-expansive fill directly below the proposed floor slab system. The non-expansive fill should be moisture conditioned to a moisture content ranging from 1 to 4 percentage points above its optimum moisture content and compacted to at least 90 percent relative compaction. Specific requirements for import fill are presented in Section 5.12.4. The non-expansive soil pad could be prepared by removing and replacing the native clay, raising the building pads above existing site grade, or a combination of both. A capillary break or other slab support system placed directly below the floor slabs should not replace in whole or part the non-expansive fill layer. The zone of non-expansive soil should extend laterally at least 3 feet outside the perimeter of the structures. Prior to placement of the non-expansive fill, the exposed clay subgrade soil to a minimum depth of 12 inches should be uniformly moisture conditioned to a moisture content ranging from 3 to 5 percentage points above the optimum moisture content and compacted to at least 88 percent relative compaction and not greater than 95 percent relative compaction, unless approved by the Geotechnical Engineer. The moisture content of the clay should be maintained until placement of the non-expansive fill. A representative from our firm should perform a field check of the soil moisture content and relative compaction prior to placement of the non-expansive fill.

Moisture Conditioning – The second alternative, which will be most applicable to concrete slabs for residences, would be to moisture condition and pre-swell the native clay prior to placement of concrete, thus reducing the potential for post-construction movement. This approach tends to be the least costly alternative and, when properly executed, the performance of floor slabs underlain by moisture-conditioned soil is comparable to slabs supported by non-expansive fill. However, it can sometimes be difficult to uniformly moisture condition and completely pre-swell the subgrade soil prior to placement of concrete. Accordingly, this approach also represents a potentially greater risk for some isolated, post-construction heaving and cosmetic structural cracking. Pre-soaking also softens and weakens the affected clay. Therefore, this approach is not appropriate in situations where floor slabs support heavy concentrated loads due to settlement and bearing concerns.

During earthwork, this procedure consists of moisture conditioning the soil within at least the upper 18 inches of final subgrade to a moisture content ranging from 1 to 5 percentage points above the optimum moisture content. Following or during moisture conditioning, the upper 12 inches of subgrade soil should be compacted to at least 85 percent relative compaction and not greater than 92 percent relative compaction, unless approved by the Geotechnical Engineer. The zone of moisture conditioning/compaction control should extend laterally at least 5 feet outside the perimeter of the structures.

Prior to placement of slab concrete, the final subgrade soil to a depth of at least 18 inches should be wetted or pre-soaked in order to uniformly raise the soil moisture content to at least 5 percentage points above its optimum moisture content or at least 2 percentage points above its plastic limit, whichever is greater. Pre-soaking is usually performed using liberal sprinkling, flooding, or other suitable method. The time required for pre-soaking could vary from a few days to over a week depending on the condition of the subgrade soils. If the building pads are kept moist or wet following earthwork, the amount and time required for pre-soaking is often reduced. Likewise, restricting vehicle or equipment traffic on the pads following earthwork will decrease the potential for over-compacting the soils and reducing the ability for water to penetrate.

A representative of our firm should perform a field check of the soil's moisture content and consistency prior to placement of slab concrete. Weather conditions at the time of construction will determine the amount of time allowed between the pre-soaking and slab placement. Generally, slab concrete should be placed no more than three days after the final field-testing. In hot and/or windy weather, slab concrete should be placed within 24 hours of the final field-testing.

Lime Treatment - The third option, which would be applicable for larger industrial and commercial structures, is to improve/stabilize the subgrade conditions by mixing the native clay with lime (lime treatment). Traditionally this procedure tends to be more cost-effective than non-expansive fill and the performance of floor slabs underlain by lime-treated soil tends to be comparable. The lime provides an added benefit in that it also acts as a cementing agent, increasing the strength and decreasing the flexibility of the subgrade soil. We have found that lime treated soil often achieves compressive strengths in the range of 300 to 500 psf soon after construction, increasing to between 500 and 1,000 psf several months after. Accordingly, floor slabs supporting equipment traffic or concentrated loads exhibit less deflection and tend to perform better overall. During or following rainfall, lime-treated soil also tends to remain reasonably stable, thus providing a firm, accessible working platform for construction. It should be noted that lime increases the pH of the soil and does not promote plant growth. Accordingly, treatment should not be performed in landscape areas or the lime-treated soils should be completely removed and replaced prior to planting.

This procedure consists of mixing the upper 16 inches of subgrade soils within the proposed floor slab area with dolomitic or high calcium quick lime and compacting the soil as engineered fill. The subgrade preparation, spreading, mixing, compacting and lime type should meet the requirements outlined in Section 24 of the Caltrans Standard Specifications. The zone of lime-treated soil should extend laterally at least 3 feet outside the perimeter of the proposed structure. Based on our previous experience, 4 percent quick lime by dry weight of the soil may be assumed for estimating purposes based on dry soil unit weight of 110 pcf.

Although lime treatment has performed well for hundreds of developments in the general project area, isolated problems have occasionally occurred due to a lack of quality control during construction, swelling if the underlying, untreated clay is dry, and/or inadequate curing following lime treatment. Accordingly, these factors are considered critically important. At least two weeks prior to lime treatment operations, laboratory tests should be performed to confirm or revise the estimated lime application rate and to further document the sulfate concentration in the near-surface soil. Also, a representative from our firm should be on-site during treatment operations to document spreading, mixing and compaction operations and provide supplemental/revised recommendations, if warranted, based on the soil conditions observed.

At least 2 to 3 days prior to spreading or mixing the lime, the moisture content of the underlying, untreated clay soil should be checked. If the soil moisture content is found to be dry of optimum, the soil moisture content should be raised using liberal sprinkling, flooding or another suitable method.

Curing is typically performed by continually sprinkling the surface of the lime-treated soil with water to keep it damp, combined with light rolling to keep the surface knitted together. We suggest that the floor slab area be covered with aggregate base or crushed rock within 2 to 3 days of the lime treatment in an effort to protect the pad and reduce drying. Periodic sprinkling should still be performed to keep the lime-treated surface damp. As an alternative, a curing seal could be applied to the lime-treated soil within one day after final compaction. A criterion for type and placement of the curing seal is presented in Section 24 of the Caltrans Standard Specifications. The curing seal may need to be reapplied several times during the curing period.

5.2.3 *Capillary Break*

Groundwater should not rise near surface and adversely impact the structural performance of the floor slabs. In areas where floor slabs will be covered with moisture-sensitive flooring, it has been common practice and industry standard in the project area to place a capillary break consisting of at least 4 inches of free draining crushed gravel on the finished subgrade soil that, in turn, is overlain by a flexible sheet membrane, such as Stego Wrap™, Moistop Plus™, or an equivalent meeting the requirements of ASTM D1745-96, that serves as a water and/or moisture vapor retarder. A copy of this ASTM standard can be provided upon request. The crushed gravel should be graded so that 100 percent passes the 1-inch sieve and less than 5 percent passes the No. 4 sieve. Care should be taken to properly place, lap and seal the membrane in accordance with manufacturers recommendations to provide a vapor tight barrier. Tears and punctures in the membrane should be completely repaired prior to placement of concrete. A 1- to 2-inch thick layer of relatively dry, fine-to medium-grained "clean" sand should be placed over the membrane to promote uniform curing of concrete and to protect the membrane. The moisture content of the sand should not exceed 4 percent by dry weight. If the sand becomes overly wet, it should be removed and replaced with suitable sand. The capillary break should not replace in whole or in part the *Subgrade Preparation* recommendations discussed in the previous subsection.

Over the past few years, problems with wet, curled and loose floor coverings have become an issue. Accordingly, prior to placement of floor coverings, moisture emissions through the concrete and the pH and relative humidity of the concrete should meet the manufacturers recommendations and requirements. A guide for preparing concrete floors that will receive moisture-sensitive floor covering is presented in ASTM F 710-03. A copy of this ASTM guide can be provided upon request. Since Kleinfelder is not a floor moisture proofing consultant or expert, it is our professional opinion that these standards should be incorporated into the project design and construction unless otherwise revised by a qualified specialist with local knowledge of slab moisture protection systems, flooring design, and other potential components that may be influenced by moisture and/or moisture vapor.

In warehouse, equipment storage, and other similar areas where the floor slabs are not covered with floor coverings or support moisture-sensitive equipment, it is common to replace the gravel and capillary break with at least 4 inches of Class 2 aggregate base that is compacted to at least 95 percent relative compaction. The aggregate base provides added support for concentrated and/or storage loads and less deflection at the slab joints caused by forklift or other equipment traffic. The moisture-proofing specialist and Structural Engineer should approve this slab support prior to final design and construction.

5.2.4 *Additional Considerations*

The project Structural Engineer should provide the final design floor slab thickness and reinforcement requirements. Care should be taken to place, consolidate, and cure concrete in accordance with American Concrete Institute (ACI) standards and criteria.

Within the project area, the subgrade improvement alternatives discussed in the previous *Subgrade Preparation* subsection have performed well in reducing the potential for post-construction heave to within generally accepted or tolerable levels. These approaches are contingent upon our assumption that drainage and landscaping criteria discussed in Section 5.9 will be implemented during and following construction. Poor drainage, inadequate landscaping and leaking pipelines can still potentially trigger some isolated slab heave as the moisture content of the native clay increases. The degree and risk of potential heaving varies depending on the approach selected and the quality control followed during construction. If the preference is to provide a performance standard higher than currently assumed for the proposed project, the level of subgrade preparation should be increased and/or the floor slabs should be stiffened by thickening the slab and/or reinforcing them with steel bars. For example, 5- to 7-inch thick slabs have been specified and/or the slabs have been reinforced with No. 3 or 4 reinforcement bars placed at 18 to 24 inches on-center each way within the middle third of the slabs. Kleinfelder can provide revised recommendations increase the performance standard, upon request.

5.3 Exterior Flatwork

Per our discussion in Section 5.0, the near-surface soil underlying the site consists predominately of clay that can exhibit significant shrink-swell (expansion) characteristics and, thus, pose a risk for post-construction movement and cracking of exterior flatwork. In order to reduce this risk, the subgrade soil conditions in all areas to support exterior concrete flatwork, i.e., sidewalks, patios, and the like, should be prepared per the recommendations presented in Section 5.12.2 - *Subgrade Preparation*. The depth of Moisture Conditioning can be reduced to at least 12 inches and the moisture content of the soils prior to placement of concrete can be reduced to at least 3 percentage points above its optimum moisture content or at least 1 percentage points above its plastic limit, whichever is more. A representative from Kleinfelder should perform a field check of the soil moisture content and consistency within 48 hours of the concrete placement. Additional criteria regarding general earthwork are presented in Section 5.12.

In some cases, isolated "edge" cracking or heaving forms along the outside portions of exterior flatwork because of seasonal or man-made wetting and drying of the subgrade soil. This potential can be reduced by placing lateral cutoffs, i.e., inverted curbs, heavy plastic membranes, or manufactured composite drains, along the outside edges of the flatwork. The lateral cutoffs typically extend vertically 12 to 18 inches into the subgrade soils. Another approach is to strengthen or stiffen the flatwork by increasing the thickness of the concrete and/or reinforcing the flatwork with steel bars rather than wire mesh. Kleinfelder can provide additional recommendations addressing these approaches upon request.

If tripping hazards are a concern, smooth dowels should be provided at all joints to reduce differential displacement. The dowels should be at least 24 inches in length, greased or sleeved at one end, and spaced at a maximum lateral spacing of 18 inches. Furthermore, flatwork, including planter boxes, should not be attached to the proposed residences or other structures. The flatwork should be allowed to "float" with the changes in volume of the soil.

The near-surface soil conditions do not necessarily warrant the placement of aggregate base below flatwork from a geotechnical standpoint. Flatwork, however, tends to perform better during and following construction with less maintenance if it is underlain by a layer Class 2 aggregate base. The aggregate base serves to provide a firm/uniform surface directly below the flatwork where surcharge stresses are highest. As a result, we have found that flatwork supported on aggregate base tends to experience less stress cracking and movement or deflection at joints. If considered, the aggregate base should have a thickness of at least 4 inches and be compacted to at least 90 percent relative compaction. In areas where concrete flatwork will support construction equipment and/or vehicle traffic, we suggest that the aggregate base be increased to a thickness of 6- to 8-inches and be compacted to at least 95 percent relative compaction.

5.4 Spread Foundations

Boring information indicates that the proposed structures may be supported on shallow, reinforced concrete spread footings founded on undisturbed native soil, engineered fill, or a combination of both. A net allowable bearing pressure of 2,000 pounds per square foot (psf) for dead plus sustained live loading may be used to size column and continuous footings supported by these materials. A one-third increase in the allowable bearing pressure may be applied when considering short-term loading due to wind or seismic forces.

An exception to the above is the very southern portion of the site where near-surface sands and silts to depths ranging from about 1½ to 4 feet below existing site grade are loose, relatively weak, and moderately compressible. It is our professional opinion, however, that these soils can support the structural foundation loads using an allowable bearing pressure of 2,000 (psf) provided the upper 6 to 12 inches of soil exposed at the base of the footing excavations is moisture conditioned as required and compacted as engineered fill using hand operated equipment ("wackers," vibratory plates or pneumatic compactors). A representative of Kleinfelder should observe the footings excavations. If loose or pliant conditions persist, the loose and pliant soils should be overexcavated to firm soils and compacted as engineered fill.

Even though computed footing dimensions may be less, continuous bearing wall and column footings should have minimum widths of 12 and 24 inches, respectively, to facilitate hand cleaning of the footing excavations and reduce the potential for localized punching shear failure. Due to the expansive soil considerations discussed in Section 5.0, all footings for one- and two-story residences and light industrial/commercial structures should be embedded at least 18 inches, respectively, below the lowest final adjacent subgrade[1]. At this depth, foundations should be supported below the critical zone of seasonal moisture fluctuations where soil shrink-swell cycles are most severe. In addition, perimeter continuous foundations would serve as a horizontal moisture break, reducing the potential for seasonal or man-made wetting and drying below the structures. Accordingly, continuous foundations should extend the entire perimeter of the buildings, including door and garage openings.

Total settlement of an individual foundation will vary depending on the plan dimensions of the foundation and the actual load supported. Based on the assumed foundation dimensions and loads, we estimate maximum total and differential foundation settlements should be on the order of ¾ and ½ inch, respectively.

Prior to placing steel or concrete, footing excavations should be cleaned of all debris, loose or soft soil, and water. If shrinkage cracks appear in the footing excavations, the excavations should be thoroughly moistened to close all cracks prior to placement of concrete. All footing excavations should be observed by the project Geotechnical Engineer just prior to placing steel or concrete to confirm that the recommendations contained herein are implemented during construction.

The structural engineer should evaluate footing configurations and reinforcement requirements to account for loading, shrinkage, and temperature stresses. As a minimum, continuous footings should be reinforced with at least two No. 4 reinforcement bars, one top and one bottom, to provide structural continuity and permit spanning of local subgrade irregularities.

5.5 Post-Tensioned Slabs

In lieu of supporting the single-family residences with conventional spread foundations and floor slabs, the proposed residences may be supported by minimum 10-inch thick, post-tensioned slab foundations. Slab edges and beams should be thickened by at least 2 inches. Design parameters are presented in the following table based on procedures outlined in Section 1816 of the 1997 Uniform Building Code (UBC). For the purpose of our evaluation, a Thornthwaite Moisture Index of –20, a generalized soil

[1] *Within this report, subgrade refers to the top surface of undisturbed native soil, native soil compacted during site preparation, or engineered fill.*

profile consisting of 3 feet of silty clay, and liquid limit, plasticity index, and fine clay content values of 66 percent, 37, and 50 percent, respectively, were used for our evaluation based on our field and laboratory data. Furthermore, we assumed that site drainage and landscaping would meet the recommendations presented in Section 5.9. If any these factors will be altered (such as thickening the clay section during grading) or not adhered to, our firm should be consulted prior to design and construction.

	Swelling Mode	
	Center Lift	**Edge Lift**
Edge Moisture Variation Distance (e_m), ft.	5.4	2.6
Differential Soil Movement (y_m), inches	1.47	0.18
Slab-Subgrade Friction Coefficient	0.80 if cast on sand 0.60 if cast on sheeting*	
Net Allowable Bearing Capacity (dead-plus-live)	1,500 psf	

* Flexible sheet membrane

During site grading, the upper 12 inches of subgrade soils below the slab foundations should be uniformly moisture conditioned to a moisture content ranging from 1 to 5 percentage points above the optimum moisture content and compacted to at least 85 percent relative compaction and not greater than 92 percent relative compaction, unless approved by the Geotechnical Engineer. Prior to placement of concrete, the upper 12 inches of subgrade soil should be wetted or pre-soaked so that the moisture content of the subgrade soil is at least 3 percentage points above its optimum moisture content or at least 1 percentage point above its plastic limit, whichever is more. Pre-soaking is usually performed using liberal sprinkling, flooding, or other suitable method. A discussion regarding pre-soaking and testing criteria is presented in Section 5.12.2 - *Subgrade Preparation.* Loose or otherwise disturbed soil areas should be repaired and trench backfill should be properly compacted prior to placement of concrete.

Post-tensioned slab foundations should be underlain by a capillary break and fine- to medium-grained coarse "clean sand as recommended in Section 5.2.3 - *Capillary Break.* The "clean" sand can be replaced with pea gravel provided an emphasis is placed on properly curing the concrete in strict accordance with ACI guidelines (ACI 308). We also suggest that concrete shrinkage tests be performed or recent data be supplied for the proposed concrete mix in order to evaluate if potential dry shrinkage is within acceptable limits or standards. In addition, the "clean" crushed gravel discussed in Section 5.2 can be omitted provided the water-cement ratio of the concrete slab does not exceed 0.50.

Since Kleinfelder is not a floor moisture proofing consultant or expert, it is our professional opinion that these recommendations and criteria be incorporated into the project design and construction unless otherwise revised by a qualified specialist with local knowledge of slab moisture protection systems, flooring design, and other potential components that may be influenced by moisture.

5.6 Lateral Resistance

Resistance to lateral loads (including those due to wind or seismic forces) may be determined using an at-rest coefficient of friction of 0.45 between the bottom of cast-in-place concrete foundations and the underlying soils. Lateral resistance for foundations can alternatively be provided by the passive soil pressure acting against the vertical face of the footings. The passive pressures available in undisturbed native soils and engineered fill may be taken as equivalent to pressures exerted by fluids weighing 350 and 400 pounds per cubic foot (pcf), respectively. These two modes of resistance can be combined. However, since horizontal movement is required to mobilize passive resistance, the allowable at-rest frictional resistance should be reduced by 50 percent.

Lateral resistance parameters provided above are ultimate values. Therefore, a suitable factor of safety should be applied for design purposes. The appropriate factor of safety will depend on the design condition and should be determined by the project Structural Engineer.

5.7 Retaining Walls

Retaining walls should be designed to resist the earth pressure exerted by the retained, compacted backfill plus any additional lateral force due to surcharge loading, i.e., construction equipment, foundations, roadways, etc., at or near the wall. The following equivalent fluid earth pressures are recommended assuming wall heights of 10 feet or less and a fully drained backfill condition:

Earth Pressure Condition	Backfill Slope	Lateral Earth Pressure (pcf)
Active	Level	35
At-Rest	Level	55

Retaining walls capable of deflecting a minimum of 0.1 percent of their height at the top may be designed using the active earth pressure. Retaining walls incapable of this deflection or that are fully constrained against deflection should be designed for the at-rest earth pressure. Where uniform surcharge loads are located within a lateral distance from constrained and unconstrained retaining walls equal to the wall height, 45 and 30 percent of the surcharge load, respectively, should be applied uniformly over the entire height of the wall.

Retaining wall backfill should be free draining, and provisions should be made to collect and dispose of excess water away from the wall. Wall drainage may be provided by either a minimum 1-foot wide layer of clean drainrock/gravel enclosed by geosynthetic filter fabric or by prefabricated drainage panels (such as Miradrain, Enkadrain, or an equivalent substitute) installed per the manufacturer's recommendations. In either case, drainage should be collected by perforated pipes and directed to a sump, storm drain, weep holes, or other suitable location for disposal. Drainrock should consist of clean, durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should conform to the requirement in Section 88 "Engineering Fabrics" of the Caltrans Standard Specifications. Caltrans Class 2 Permeable Material meeting the requirements of Section 68-1.025 of the Standard Specifications can be substituted for the clean drainrock and filter fabric following review and approval by the Geotechnical Engineer. The upper 12 inches of engineered backfill above the wall drainage should consist of native soil, concrete, asphalt-concrete, or similar backfill to reduce surface drainage into the wall drain system.

If retaining walls are 4 feet or less in height, the perforated pipe may be omitted in lieu of weep holes on 4-foot, center-to-center maximum spacing. The weep holes should consist of 2-inch or larger diameter holes (concrete walls) or unmortered head joints (masonry walls). They should be placed as low as possible but not higher than 18 inches above the lowest adjacent grade. Two 8-inch square overlapping patches of geosynthetic filter fabric should be affixed to the rear wall openings of each weep hole to retard soil piping.

All backfill should be placed and compacted in accordance with recommendations provided herein for engineered fill. During grading and backfilling adjacent to any walls, heavy equipment should not be allowed to operate within a lateral distance of 5 feet from the wall or within a lateral distance equal to the wall height, whichever is greater, to avoid overstressing of the wall. Within this zone, only hand operated equipment ("whackers," vibratory plates, or pneumatic compactors) should be used to compact backfill soils.

Expansive soils, i.e., clay, plastic silt, and/or clayey sand, should not be used for backfill against retaining walls unless approved by the geotechnical engineer. The wedge of nonexpansive backfill material should extend from the bottom of each retaining wall outward and upward at a slope of 1(h):1(v) or flatter.

5.8 Asphalt Concrete Pavements

5.8.1 Subgrade Preparation

Per our discussion in Section 5.0, the near-surface soil encountered consisted of potentially expansive clay that poses a potential risk for post-construction heave and cracking of pavements. In order to reduce this risk and improve the pavements service life, the subgrade soils in pavement areas should be thoroughly scarified or ripped to a minimum depth of 12 inches below the finished subgrade elevation and uniformly moisture conditioned to a moisture content ranging from 2 to 4 percentage points above the optimum moisture content. During or following moisture conditioning, the upper 6 inches of subgrade soil should be compacted as engineered fill to at least 95 percent relative compaction. The underlying 6 inches of moisture conditioned subgrade soil should be compacted to at least 90 percent relative compaction. The subgrade soil should be in a stable, non-pumping condition at the time aggregate base materials are placed and compacted. The moisture content of the soils should be maintained until placement of the aggregate base by liberal sprinkling with water or other suitable method. If there will be a delay between placing the aggregate base and asphalt-concrete, the aggregate base should also be periodically sprinkled or wetted to prevent drying of the underlying subgrade soil. A representative from our firm should perform a field check of the soil moisture content and relative compaction prior to placement of aggregate base.

5.8.2 Pavement Sections

Our experience on several projects in the area indicates that the subgrade clay exhibits poor support characteristics for pavements as presented by R-values less than 5. In the very southern portion and in isolated pockets elsewhere within the site, more sandy and silty near-surface soils exist as confirmed by the R-value test result of 34 at location RV-2. In other subdivisions where this transition of soil types has occurred, such as Weston Ranch and Spanos Park, numerous R-value tests have been required to delineate where a change in structural section would be appropriate. Even with occasional test results similar to the 34 at location RV-2, the public works department has been reluctant to allow a design R-value higher than 20 or 25. One reason is that during the completion of underground work in the streets, lower quality soil is often placed near the surface as backfill.

For planning purposes, we have included pavement sections (determined in units of inches rounded up to the nearest ½ inch) below based on a minimum R-value of 5 and 20, current Caltrans design procedures, traffic indices (TI's) ranging from 4 to 7, and our assumption that Caltrans construction tolerances are acceptable. Pavement sections for TI's ranging from 4 to 7 do not include a Gravel Equivalent Safety Factor (per County Engineers Association and the League of California Cities criteria). Pavement sections for a TI greater than 7 include a Gravel Equivalent Safety Factor of 0.20 per Caltrans highway design criteria. Some jurisdictions may require that a Gravel Equivalent Safety Factor be included for design of all pavements as well as minimum asphaltic concrete sections. If required, the pavement sections should be reevaluated. The project Owner and/or Civil Engineer should review the pavement sections and evaluate the suitable TI's for this project[2].

R-Value	Traffic Index	Asphalt-Concrete (inches)	Class 2 Aggregate Base (inches)
5	4	2	9
	4.5	2	10½
	5	2	12
	5.5	2	14
	6	2½	15
	6.5	2½	16½
	7	3	17½
	8	5	17½
20	4	2	7
	4.5	2	8
	5	2	9½
	5.5	2	11
	6	2½	11½
	6.5	2½	13½
	7	3	10½
	8	5	13½

The pavement sections provided above are contingent on the following recommendations being implemented during and following construction.

- Aggregate base and asphalt concrete materials and placement methods should conform to the current Caltrans Standard Specifications. Class 2 aggregate should be compacted as engineered fill to at least 95 percent relative compaction.
- Adequate drainage (both surface and subsurface) should be provided such that the subgrade soils and aggregate base materials are not allowed to become wet. Pavement sections should be isolated from intrusion of water at all locations where pavements are adjacent to irrigated landscaping or areas that may pond water. For long-term performance, pavement edge drains should be placed to collect water and to convey it to a storm drain or other drainage facility. As an alternative, but one that tends to be less effective, edge barriers, such as concrete curbs, polyethylene membranes and the like, should be placed that extend a minimum of 4-inches below the

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[2] *The traffic index (TI) is a measure of traffic wheel loading frequency and intensity of anticipated traffic. For comparison, TI's of between 4 and 5 are often suitable for design of average residential streets and minor or secondary collectors. TI's of between 5.5 and 6.5 are commonly used for design of major or primary collectors between minor collectors and major arterials. TI's of 7 or greater are common for design of commercial roads, connector roads or major streets with heavy traffic.*

aggregate base and into the subgrade soil. Additional details regarding these systems can be provided upon request.

- Periodic maintenance should be performed to repair degraded areas and seal cracks with appropriate filler.

The pavement sections provided above are based on the soil conditions encountered during our field investigation, our assumptions regarding final site grades, and limited laboratory testing. The actual pavement subgrade materials exposed during grading may differ from those tested because of earthwork operations or natural variations in soil conditions. A representative from our firm should observe the subgrade conditions following rough grading. If the subgrade conditions vary from those anticipated, additional soil samples will need to be obtained and additional R-value tests performed. Should the R-value test results vary significantly from the R-value used for our pavement section design, the recommended sections will need to be revised.

5.9 Site Drainage and Landscaping

Foundation and slab performance depends greatly on how well runoff water drains from the site. Accordingly, positive drainage should be provided away from building pad and pavement areas toward appropriate drop inlets or other surface drainage devices without ponding. The drainage should be maintained both during construction and over the life span of the project. Landscaping after construction should not promote ponding of water adjacent to the structures. Roof draining should be installed with appropriate downspout extensions outfalling on splash blocks so that water is directed a minimum of 5 feet horizontally away from the structures or be connected to the storm drain system for the development. This method of roof runoff containment has the advantage of protection from owner alterations.

A number of post-construction landscape practices beyond the control of the design engineers can occur to cause distress to structures founded on expansive clay. To reduce potential movement of the soil, watering and preferably landscaping should be done on all sides adjacent to the foundation, and care should be taken to not over irrigate and to maintain a leak free sprinkler piping system. Watering should be done in a uniform, systematic manner as equally as possible on all sides to maintain the soil moisture content consistent around the perimeter of the foundation. Areas of soil that do not have ground cover may require more watering as they are more susceptible to evaporation. During extreme dry periods, close observations should be made around the foundations to ensure that adequate watering is being provided to keep soil from separating or pulling back from the foundation. Finally, trees should not be placed closer to the structures than a horizontal distance equal to one-half the mature height of the tree and other vegetation over six feet in height should not be planted within 20 feet of the building perimeters unless measures are taken to prevent roots from penetrating below the homes.

Homeowners should be made aware of the risks associated with expansive soils and the importance of maintaining positive drainage, the use of properly placed drains, and proper landscaping and watering. Homeowners should also be made aware that potential man-made water sources such as buried pipelines, drains, swimming pools, garden ponds and the like should be periodically tested and/or examined for signs of leakage or damage. Any such leakage or damage should be promptly repaired. Kleinfelder can help draft an appropriate letter to the homeowners, if desired. Similar letters should be considered where compressible or erodible soils exist or where fill/cut slopes occur.

5.10 CBC Seismic Design Criteria

The project site lies within Seismic Zone 3 as shown on Figure 16A-2 of the 2001 CBC. The nearest Seismic Source Type A fault is mapped greater than 15 kilometers (km) from the project site and the nearest Seismic Source Type B fault is mapped greater than 10 km from the site. Accordingly, near-source amplification factors do not need to be considered for design per Table 16A-S and 16A-T of the CBC. The upper 100 feet of soil underlying the site should meet the criteria for soil profile type S_D as defined in Table 16A-J of the CBC.

5.11 Soil Corrosion

Chemical tests performed on a selected subgrade soil sample indicated a pH of 8.0 a chloride concentration of 25 mg/kg and non-detectable concentrations of sulfate. Per California Test 532, "if the chloride concentration is determined to be less than 500 parts per million," "the influence of the chloride-ion at this level is considered to be non-corrosive."

Minimum resistivity tests performed on the same soil sample indicated that the soil is moderately corrosive to buried metal objects as indicated by a result of 2,834 ohm-centimeters. A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is provided below.

Soil Resistivity	Corrosivity
0 to 1,000 ohm-cm	Severely corrosive
1,000 to 2,000 ohm-cm	Corrosive
2,000 to 10,000 ohm-cm	Moderately corrosive
Over 10,000 ohm-cm	Mildly corrosive

Kleinfelder has performed these soil corrosivity tests as requested by the client. These tests are only an indicator of soil corrosivity. Kleinfelder is not a corrosion consultant or expert. You may wish to retain a competent corrosion engineer to design corrosion protection systems appropriate for this project.

5.12 General Earthwork

The following presents recommendations for general earthwork criteria. Previous sections should be reviewed for specific or supplemental earthwork recommendations.

5.12.1 Site Stripping

Prior to general site grading, surface vegetation, organic topsoil, and any debris should be removed and disposed of outside the construction limits. Depending on the concentration of vegetation, it may be possible to mow and rake off the surface vegetation and disc the remaining roots into the surface during subgrade preparation. The organic content of the disced soil (as determined by loss-on-ignition tests) should not exceed 5 percent by weight. Deep stripping will be required where concentrations of organic soils or tree roots are encountered during site grading. The depth of stripping and/or discing should be determined in the field by a representative of Kleinfelder prior to earthwork. Upon approval of the owner and/or landscape architect, stripped topsoil (less any debris) may be stockpiled and placed in landscape areas. This material, however, should not be incorporated into any engineered fill.

Although not encountered or identified during our investigation, it is possible that buried objects such as abandoned utility lines, septic tanks, cesspools, wells, foundations, etc., exist on site. If encountered within the area of construction, these items should be removed and disposed of off-site. Existing wells should be abandoned in accordance with applicable regulatory requirements. Existing utility pipelines that extend beyond the limits of the proposed construction and will be abandoned in-place should be plugged with cement grout to prevent migration of soil and/or water. All excavations resulting from removal activities should be cleaned of loose or disturbed material and dish-shaped with sides sloped 3(h):1(v) or flatter to permit access for compaction equipment.

5.12.2 Subgrade Preparation

Previous sections discuss specific subgrade preparation recommendations related to concrete floor slabs, foundations, exterior flatwork, retaining walls, and pavements. Where not specifically addressed by these previous sections, all subgrade areas that will receive engineered fill for support of structures should be scarified to a depth of at least 6 inches, uniformly moisture conditioned to a moisture content ranging from 1 to 5 percentage points above the optimum moisture content, and compacted as engineered fill to at least 90 percent relative compaction and not greater than 95 percent relative compaction, unless approved by the Geotechnical Engineer.

In-place scarification and compaction may not be adequate to densify all disturbed soil within areas grubbed or otherwise disturbed below a depth of about 6 inches. Therefore, overexcavation of disturbed soil, scarification and compaction of the exposed subgrade, and replacement with engineered fill may be required to sufficiently densify all disturbed soil.

Following rough grading, construction and trenching activities often loosen or otherwise disturb the subgrade soils. On occasion, this disturbance can lead to isolated movement of the subgrade soils following construction and cracking of overlying slabs and pavement. Accordingly, loose/disturbed areas should be repaired and trench backfill should be properly compacted prior to placement of concrete.

5.12.3 Temporary Excavations

Construction site safety generally is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a lateral distance equal to one-third the slope height from the top of any excavation. During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water encountered within excavations should be collected and disposed of outside the construction limits.

5.12.4 Fill Materials

The native soils encountered in our borings, minus organics, debris and/or other deleterious materials, should be suitable for use as engineered fill in proposed building areas. However, the native clay is considered potentially expansive. Therefore, clay fill placed and prepared in floor slab, flatwork, retaining wall, or pavement areas should be addressed as previously discussed in the appropriate sections of this report.

All import fill soils should be nearly free of organic or other deleterious debris, essentially non-plastic, and less than 3 inches in maximum dimension. In general, well-graded mixtures of gravel, sand, non-plastic silt, and small quantities of cobbles, rock fragments, and/or clay are acceptable for use as import fill. All imported fill materials to be used for engineered fill should be sampled and tested by the project Geotechnical Engineer prior to being transported to the site. Specific requirements for import fill are provided below.

Gradation (ASTM C136)	
Sieve Size	Percent Passing
3-inch	100
No. 4	50 – 100
No. 200	15 – 70
Plasticity (ASTM D4318)	
Liquid Limit	Plasticity Index
Less than 30	Less than 12
Organic Content (ASTM D2974)	
Less than 3 percent	

Trench backfill and bedding placed within existing or future city right-of-ways should meet or exceed the requirements outlined in the current city specifications. Trench backfill or bedding placed outside existing or future right-of-ways could consist of native or imported soil that meets the requirements for fill material provided above. However, coarse-grained sand and/or gravel should be avoided for pipe bedding or trench zone backfill unless the material is fully enclosed in a geotextile filter fabric such as Mirafi 140N or an equivalent substitute. In a very moist or saturated condition, fine-grained soil can migrate into the coarse sand or gravel voids and cause "loss of ground" or differential settlement along and/or adjacent to the trenches, thereby leading to pipe joint displacement and pavement distress.

Utility trenches backfilled with sand or other permeable material can act as a conduit for exterior surface water to enter below structures. Accordingly, native clay or lean concrete should be used as backfill for a minimum lateral distance of 2 feet on each side of the exterior building line to act as a "plug."

Trench backfill recommendations provided above should be considered minimum requirements only. More stringent material specifications may be required to fulfill bedding requirements for specific types of pipe. The project Civil Engineer should develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

5.12.5 Engineered Fill

All fill soils, either native or imported, required to bring the site to final grade should be compacted as engineered fill. Unless otherwise noted in previous sections, fill or native subgrade soil composed of potentially expansive clay should be <u>uniformly</u> moisture conditioned to a moisture content ranging from 3 to 5 percentage points above the optimum moisture content, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at least 90 percent of the maximum dry density and not greater than 95 percent of the maximum dry density as determined by ASTM Test

Method D 1557[3], unless approved by the Geotechnical Engineer. Import fill or native soil composed of non-expansive sand and silt should be uniformly moisture conditioned to a moisture content ranging from 1 to 4 percentage points above the optimum moisture content, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at least 90 percent of the maximum dry density. Fills exceeding 5 feet in thickness should be compacted to at least 95 percent relative compaction for their full depth. Additional fill lifts should not be placed if the previous lift did not meet the required dry density or if soil conditions are not stable. Discing and/or blending may be required to uniformly moisture condition soils used for engineered fill.

All trench backfill in building or other structural areas should be placed and compacted in accordance with the recommendations provided above for engineered fill. During backfill, mechanical compaction of engineered fill is recommended. Backfill placed in trenches located outside of building or other structural areas can be consolidated in-place by jetting in lieu of mechanical compaction. A common jetting procedure consists of filling the trenches with backfill soils (maximum 8 foot thick lift) to within 3 feet of finished grade and then thoroughly saturating the backfill with water by inserting jetting rods in an up and down ramming fashion at a spacing of about 4 to 5 feet along the central portion of the trench. If any dry pockets of backfill are noticed, the trench should be re-jetted. The jetted backfill should then be allowed to "rest" for a period of time (typically 2 to 3 days) to allow excess water to drain and consolidation to occur. Following the rest period, the backfill at the top should then be rolled with track equipment, such as a mudcat, or a sheepsfoot compactor attached to the arm of an excavator to further consolidate the backfill and detect any excessively soft or pliant areas. Once the jetted backfill has adequately consolidated, the upper 3 feet of backfill should be placed and mechanically compacted as engineered fill.

Jetting will not achieve the same level of compaction as mechanical compaction, therefore, jetted backfill will not typically meet compaction standards. The relative compaction of jetted soil typically ranges between about 80 and 90 percent. Accordingly, compaction tests are not normally performed. Instead, a performance criterion rather than a compaction standard should be specified for jetted backfill. As a result, it is important that experienced personnel observe the jetting operation and consolidation to document that the procedure has been adequately performed and that the trench is ready for final backfill.

5.12.6 Wet/Unstable Subgrade Mitigation

Based on our findings and historical records, groundwater levels are not anticipated to rise near surface or impede grading operations at the site. However, if site grading is performed during or following extended periods of rainfall, the moisture content of the

[3] *This test procedure should be used wherever relative compaction, maximum dry density, or optimum moisture content is referenced within this report.*

near-surface soils may be significantly above optimum. This condition, if encountered, could seriously delay grading by causing an unstable subgrade condition. Typical remedial measures include discing and aerating the soils during dry weather, mixing the soils with dryer materials, removing and replacing the soils with an approved fill material, stabilization with a geotextile fabric or grid, or mixing the soils with an approved hydrating agent such as a lime or cement product. Our firm should be consulted prior to implementing any remedial measure to observe the unstable subgrade condition and provide site-specific recommendations.

If construction is to proceed during the winter and spring months, one way to reduce the exposure of the pad and potential repairs is to leave the subgrade at least 1 foot above the proposed subgrade elevation, cutting it down immediately before placing the capillary break and floor slab. The cut areas should be proof-rolled at the discretion of the geotechnical engineer to identify whether undercutting of any remaining wet/unstable soils is required. Cut soils can be placed in landscape areas or disced and aerated (dried) during dry weather for placement in pavement, future pad, or other areas.

6.0 ADDITIONAL SERVICES

The review of plans and specifications, field observations, and testing by Kleinfelder, Inc. is an integral part of the conclusions and recommendations made in this report. If Kleinfelder, Inc. is not retained for these services, the client agrees to assume Kleinfelder, Inc.'s responsibility for any potential claims that may arise during construction. The actual tests and observations by Kleinfelder, Inc. during construction will vary depending on type of project and soil conditions. The tests and observations would be additional services provided by our firm. The costs for these services are not included in our current fee arrangements.

As a minimum, our construction services should include observation and testing during site preparation, grading, and placement of engineered fill and observation of foundation excavations prior to placement of reinforcing steel. Many of our clients are finding it helpful to have concrete compressive tests on each lot even though this information may not be required by any agency. It may also be helpful to perform a floor level and crack survey of all slab-on-grade floors prior to the application of any floor covering. The floor level survey can be readily performed by the client or as an additional service provided by Kleinfelder using a manometer device.

7.0 LIMITATIONS

1. The conclusions and recommendations of this preliminary report are for design purposes for the Tidewater Crossing project as described in the text of this report. The conclusions and recommendations in this report are invalid if:

   - The assumed structural or grading details change
   - The report is used for adjacent or other property
   - Changes of grades and/or groundwater occur between the issuance of this report and construction
   - Any other change is implemented which materially alters the project from that proposed at the time this report was prepared

2. The conclusions and recommendations in this report are based on the borings drilled for this investigation. It is possible that variations in the soil conditions exist between or beyond the points of exploration, or the groundwater elevation may change, both of which may require additional investigations, consultation, and possible design revisions.

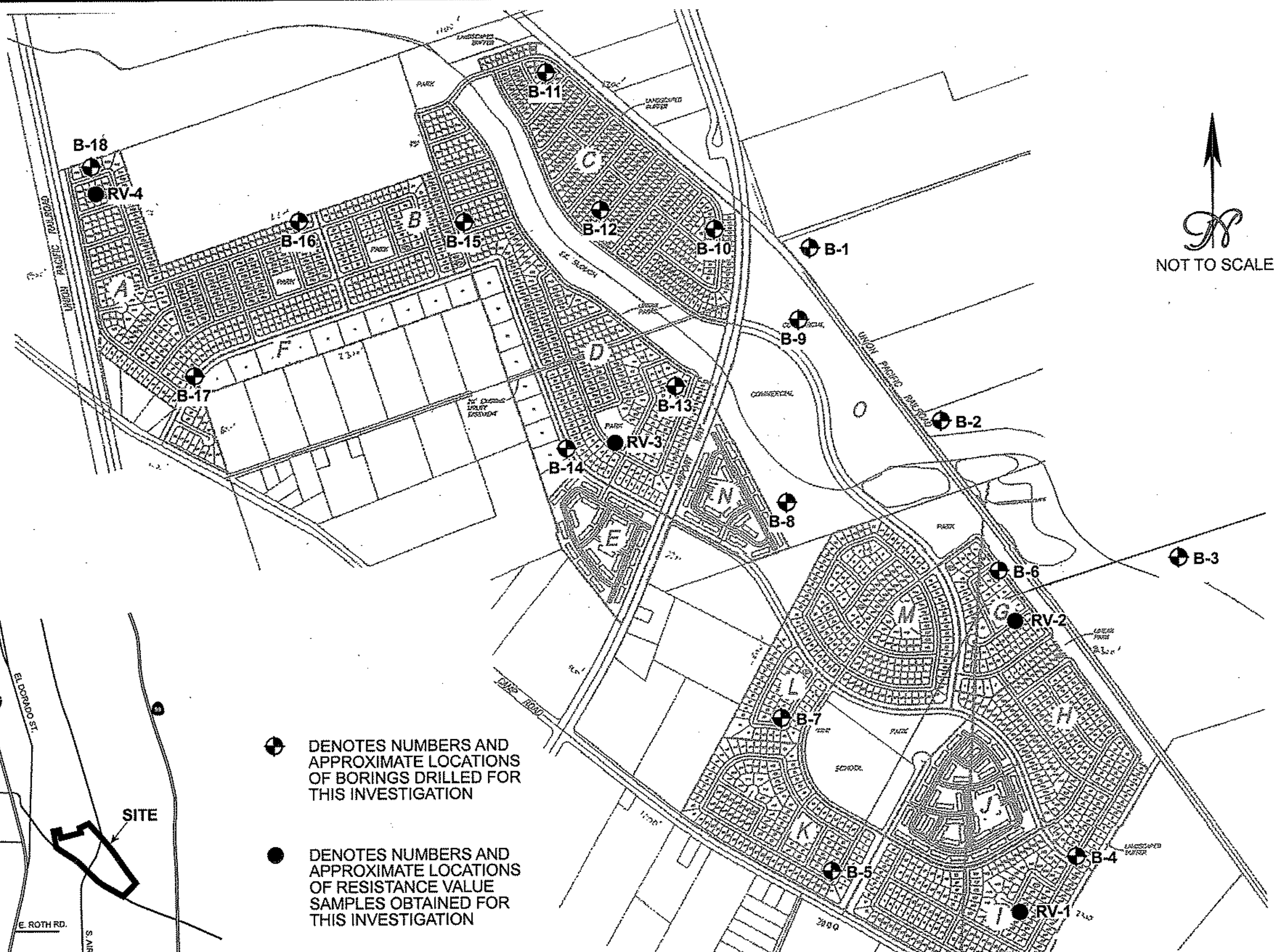
3. We are not corrosion engineers. You may wish to retail a competent corrosion engineer to design corrosion protection systems appropriate for the project.

4. It is emphasized that we are not floor moisture proofing consultants or experts. We make no guarantee nor provide any assurance that the slab underlayment discussed in Section 5.2.3 - *Capillary Break* will reduce concrete slab-on-grade floor moisture penetration to any specific rate or level, particularly those required by floor covering manufacturers, or inhibit mold growth. Qualified specialists with local knowledge of slab moisture protection systems, flooring design, and other potential components that may be influenced by moisture should be consulted. Our study addresses present subgrade conditions only and does not evaluate future potential conditions for support of slabs unless specifically stated otherwise.

5. This report was prepared in accordance with the generally accepted standard of practice that existed in San Joaquin County at the time the report was written. No warranty, expressed or implied, is made.

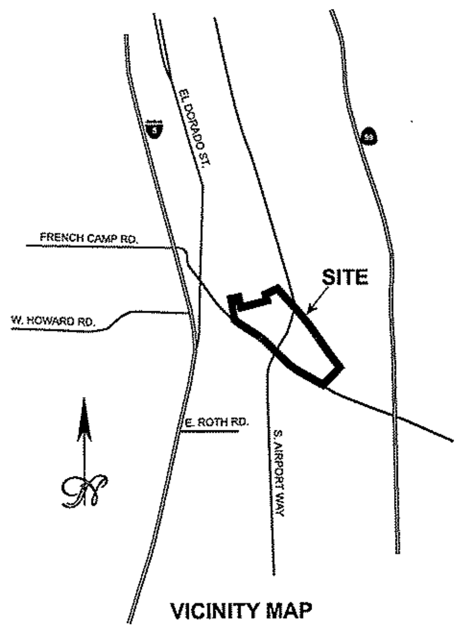
6. It is the CLIENT'S responsibility to see that all parties to the project, including the designer, contractor, subcontractor, etc., are made aware of this report in its entirety.

7. This report may be used only by the client and only for the purposes stated within a reasonable time from its issuance, but in no event later than three years from the date of the report. Land use, site conditions (both on- and off-site), or other factors may change over time, and additional work may be required. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else, unless specifically agreed to in advance by Kleinfelder in writing, will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.



DENOTES NUMBERS AND APPROXIMATE LOCATIONS OF BORINGS DRILLED FOR THIS INVESTIGATION

DENOTES NUMBERS AND APPROXIMATE LOCATIONS OF RESISTANCE VALUE SAMPLES OBTAINED FOR THIS INVESTIGATION



VICINITY MAP

KLEINFELDER

DATE PRODUCED:3/7/2006	DATE REVISED:
PROJ. NO.:64183.G01	FILENAME:STO6D157.FH11

SITE PLAN AND VICINITY MAP
TIDE WATER CROSSING PROJECT
STOCKTON, CALIFORNIA

PLATE No.

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